RESPONSE OF CHINESE TARO (Colocasia esculenta (L.) Schott var. 'Bun Long') TO NITROGEN AND POTASSIUM FERTILIZATION

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Abstract

The response of Chinese Taro (Colocasia esculenta (L.) Schott variety 'Bun Long') to 12 treatment combinations of nitrogen (N) and potassium (K) was determined on a crop grown for 9 months. Nitrogen had the greatest effect on weight of number 1 corms while K had relatively little effect. The highest yields were obtained with the higher rates of N (>320 lb N/acre) at all rates of K. A predicted net revenue of $16,200 to $17,000 may be achieved with applications of 460 and 600 lb N (1000 and 1305 lb Urea) per acre at all rates of K and also with 320 lb N and 600 lb K (695 lb urea and 1185 lb muriate of potash) per acre. A tentative fertilizer recommendation for the highest net revenue is 460 lb N (1000 lb urea) and 600 lb K (1185 lb muriate of potash) per acre. A tentative adequate range for leaf N at 3 months is 4.3 to 4.5 per cent and for leaf K is 4.1 to 4.3 per cent.

Introduction

Chinese Taro (Colocasia esculenta (L.) Schott variety 'Bun Long'), has been grown on the Hilo Coast for several years and is principally used for making taro chips. Some of it is also sold on the fresh market in Hawaii and shipped to the fresh market on the Mainland USA. A project funded by the Governor's Agriculture Coordinating Committee (GACC) is studying the fertility requirements of Chinese Taro to determine if yields can be increased by improved fertilization and also to develop management practices that will produce economically feasible yields. The results reported here are those of a single nitrogen (N) by potassium (K) fertilizer experiment and the conclusions are tentative until they are confirmed by additional experiments.

Experimental Procedures

The N by K experiment was conducted at the Waianuenue farm laboratory plots of the College of Agriculture at Hilo. This land had not been previously planted to edible ginger and was situated at the 500 foot elevation. The soil was classified as the Hilo Series of the Typic Hydrandepts. The experimental area was fumigated with methyl bromide several weeks before planting. The preplant soil analysis[1] is given below:

pH:	5.4 - 5.5	K :	32.1 - 56.0 ppm
P :	23.8 - 27.6 ppm	Ca:	130.9 - 297.3 ppm
Mg:	57.0 - 122.3 ppm		

[1]pH - 1:1 soil:water; P - Modified Truog extractant; K,Ca, Mg - N ammonium acetate, pH 7.0.

The fertilizer treatments were added as urea for nitrogen and muriate of potash for potassium. The total amount of fertilizer for each treatment was divided into 6 equal doses which were applied at planting and at monthly intervals to 5 months after planting. From 2.1 to 2.6 tons of crushed coral (calcium carbonate) per acre were broadcast before planting and incorporated to raise soil pH to 6.0. Treble superphosphate (510 lb per acre) and magnesium sulfate (1013 lb per acre) were banded in 6-inch deep furrows and tilled into the top 6 inches of soil along with the preplant nitrogen and potassium applications. The experiment was installed in a randomized complete block design with 3 replicates.

Hulis (planting material) were 1 to 3 inches in diameter at the base and were planted approximately 4 inches deep on March 19, 1987. Hulis were spaced 1 foot apart within rows and 3 feet apart between rows which gave a plant population of 14,520 plants per acre. The experiment was harvested on December 15, 1987, 9 months after planting, and 25 plants were collected from each plot (9 x 24 ft). The average corm weights were recorded for each plot and the data presented are the averages over the three replicates.

Results and Discussion

Observed Corm Yield

The observed average corm yields for each treatment combination are presented in Table 1 where it is apparent that the highest yields were generally achieved with N applications between 320 and 600 lbs per acre at all K levels. Thus N had a greater effect on corm yield than did K in this experiment. The highest marketable yield (44,425 lb per acre) was achieved with the combination of 460 lb N and 460 lb K per acre. While the highest number 1 corm yield (43,506 lb per acre) was attained with 320 lb N and 600 lb K per acre.

Predicted Yield and Revenue

Yield prediction equations were developed which included applied N and K in a quadratic model. The predicted number 1 corm yields are presented in Table 2 in which the highest yields (38,636 to 39,873 lb per acre) are found with 600 lb N per acre with all rates of K as well as with 460 lb N with 460 and 600 lb K per acre. In the case of the highest predicted off-grade corms (Table 3), N levels of 460 and 600 lb per acre at all rates of K and also 320 lb N per acre with 460 and 600 lb K per acre produced yields of 3,000 lb per acre or greater. The increase in predicted number 1 corm yields with increasing urea applications is shown in Figure 1 in which the highest yields are achieved with urea over 1000 lbs per acre at the highest muriate of potash level (1185 lb per acre).

The predicted net revenue shown in Table 4 was calculated on the basis of the cost of urea and muriate of potash only. The predicted total marketable yield was assumed to be composed of 87% number 1 corms and 7% off-grade corms, which was the average for this experiment. It was assumed that the price of number 1 corms was $.40 per lb and the price of off-grade corms was $.35 per lb. Predicted net revenue of over $16,200 per acre was achieved with 460 and 600 lb N (1000 and 1305 lb urea) per acre at all rates of K and also with 320 lb N and 600 lb K (695 lb urea and 1185 lb muriate of potash) per acre. Predicted net revenue increased more rapidly with increased N application than with increased K application which follows from the greater effect of N than K on the observed yields. The highest predicted net revenue was $17,008 per acre with 460 N and 600 K.

Leaf Tissue Analysis

Samples of the most recent fully expanded leaves were collected at 8, 15, 25, and 36 weeks after planting and it was found that the nutrient levels of the 15-week sample were the most closely related to corm yield. The macronutrient concentrations in the 15-week samples are presented in Table 5. The optimum range of leaf N appeared to be between 4.3 and 4.5 %, while the optimum range for leaf K appeared to be between 4.1 and 4.3 %. These levels are in the ranges proposed by Plucknett and de la Peña, 1971. Phosphorus levels are above the adequate levels reported by these workers and in the range of those reported by de la Peña et al, 1979. Leaf Ca levels are lower than those given by de la Peña et al, 1979, even though over 2 tons of lime had been applied and pH was at 6.0 and above. Leaf Mg appeared adequate. Micronutrients determined in leaf tissue were generally comparable to those of de la Peña et al, 1979, except for Cu and Zn which were about one-half the levels reported (Table 6). Analysis of leaf tissue at about 3 months for N and K, in particular can be a useful management tool which indicates the nutrient status of a

crop of taro when there is still time to make additional applications to correct deficiencies which could improve yields.

Supplementary Treatments

Four supplementary treatments were included in the experiment to obtain a first approximation of the response of taro at this site to phosphorus, lime (pH), and boron. The treatments shown below were replicated 3 times.

Trt.	lb/acre				lb/acre		
No.	Urea	(N)	Muriate	(K)	Treb. Sup Phos.	pH	Borax
13	695	320	630	320	0	6.0	0
14	695	320	630	320	510	5.2	0
15	695	320	630	320	510	6.5	0
16	695	320	630	320	510	6.0	5
"Standard" treatment (7)							
7	695	320	630	320	510	6.0	0

Figure 2 indicates that there was little difference in the average weight of number 1 corms produced per acre among the supplementary treatments and compared to treatment 7. This suggests that taro will not respond to treble super phosphate applications on this soil with modified Truog phosphorus levels of 23.8 to 27.6 ppm. It also suggests that taro was not very sensitive to pH on this soil. Finally, the addition of boron did not appear to be needed. An interesting finding, however, was that the per cent rotted corms was lowest with pH 6.5 (Figure 3). One must be careful in interpreting this because the percent rotted corms was higher with pH 6.0 than with pH 5.2 so this result may have been due to chance. Leaf Ca reflected the amounts of Ca applied to the various treatments (Figure 4).

Rainfall

The weekly rainfall during the crop period is presented in Appendix 1. The total rainfall measured for the crop was 144.9 inches which was distributed as follows: 48.4 inches at the end of the first three months, 41.1 inches during the next three months, and 55.4 inches during the last three months.

Tentative Fertilizer Recommendation

On the basis of the predicted yields and predicted net revenue per acre of marketable corms, the highest return for N and K fertilizer application is estimated to be with the application of 460 lb N (1000 lb urea) and 600 lb K (1185 lb muriate of potash) per acre. If the crop receives adequate rainfall, a total marketable yield of 40,000 lb per acre is predicted with 14,520 plants per acre (1 x 3 ft spacing). Individual corms would be expected to average about 3 lb. This fertilizer recommendation may be expressed as 2000 lb/acre/crop of a 23-0-36 formulation. It must be remembered that these predictions are based on only one experiment in one location so may not be directly applicable to other locations and weather conditions. However, they do provide an estimate of what may be possible. It should be noted in Table 4 that returns of over $16,200 per acre are predicted with N applications of 460 to 600 lbs per acre (1000 to 1305 lb urea) and a range of K (muriate of potash) applications as well as with 320 lb N and 600 lb K (695 lb urea and 1185 lb muriate of potash) per acre.

Acknowledgements

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References

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de la Peña, R., P. Vander Zaag, and R.L. Fox. 1979. The comparative phosphorus requirements of flooded and non-flooded taro. Provisional Report No. 5. Taro and Cocoyam. International Foundation for Science. p.223-237.

Table 1. Observed Average Corm Yields by Treatment

	Test Treatment (lbs per acre)				Corm Yield (lbs per acre)[1]		
	Urea	(N)	Muriate	(K)	No. 1	Off-grade	Marketable
1.	0	(0)	0	(0)	19,562	3,912	23,474
2.	110	(50)	100	(50)	32,978	492	33,470
3.	695	(320)	100	(50)	40,199	1,132	41,331
4.	1305	(600)	100	(50)	36,791	2,874	39,665
5.	415	(190)	375	(190)	30,292	2,713	33,005
6.	110	(50)	630	(320)	31,595	2,829	34,424
7.	695	(320)	630	(320)	31,547	4,895	36,442
8.	1305	(600)	630	(320)	40,949	602	41,551
9.	1000	(460)	910	(460)	42,056	2,369	44,425
10.	110	(50)	1185	(600)	35,750	1,577	37,327
11.	695	(320)	1185	(600)	43,506	622	44,128
12.	1305	(600)	1185	(600)	39,116	4,278	43,394

[1] Yield per acre is based on 14,520 plants per acre and adjusted by percent no. 1 and percent off-grade in each treatment.

Table 2. Predicted Yield per Acre of No.1 Corms.[1]

Lbs per Acre: Muriate (K)		Lbs per Acre: Urea (N)					
		0(0)	100(50)	415(190)	695(320)	1000(460)	1305(600)
0	(0)	26,615	28,541	33,126	36,320	38,613	39,718
100	(50)	26,692	28,583	33,071	36,175	38,371	39,378
375	(100)	27,244	29,038	33,254	36,104	38,028	38,764
630	(320)	28,200	29,904	33,867	36,482	38,153	38,636
910	(460)	29,707	31,314	35,004	37,367	38,766	38,975
1185	(600)	31,710	33,219	36,637	38,747	39,873	39,811

[1]Based on 14,520 plants per acre with 87% no.1 corms.

Table 3. Predicted Yield per Acre of Off-grade Corms.[1]

Lbs per Acre: Muriate (K)		Lbs per Acre: Urea (N)					
		0 (0)	100(50)	415(190)	695(320)	1000(460)	1305(600)
0	(0)	2,141	2,296	2,665	2,922	3,107	3,196
100	(50)	2,148	2,300	2,661	2,911	3,087	3,168
375	(100)	2,192	2,336	2,676	2,905	3,060	3,119
630	(320)	2,269	2,406	2,725	2,935	3,070	3,108
910	(460)	2,390	2,520	2,816	3,007	3,119	3,136
1185	(600)	2,551	2,673	2,948	3,118	3,208	3,203

[1]Based on 14,520 plants per acre with 7% off-grade corms.

Table 4. Predicted Net Revenue per Acre of Marketable Corms.[1]

Lbs per Acre: Muriate (K)		Lbs per Acre: Urea (N)					
		0(0)	100(50)	415(190)	695(320)	1000(460)	1305(600)
0	(0)	$11,396	$12,217	$14,172	$15,532	$16,506	$16,971
100	(50)	$11,425	$12,232	$14,146	$15,467	$16,399	$16,823
375	(100)	$11,653	$12,418	$14,215	$15,428	$16,244	$16,551
630	(320)	$12,054	$12,781	$14,469	$15,582	$16,289	$16,488
910	(460)	$12,691	$13,376	$14,948	$15,952	$16,543	$16,625
1185	(600)	$13,539	$14,183	$15,638	$16,534	$17,008	$16,973

[1]Based on 14,520 plants per acre with 87% no.1 corms and 7% off-grades. The price of no.1 corms is $0.40 and of off-grades is $0.35. The cost of Urea is $250.29/ton and of Muriate of Potash is $249.26/ton.

Table 5. Analysis of Leaf Tissue at 15 Weeks: Macronutrients

Treatment (lb/acre) No.	Urea	Muriate	N	P	K	Ca	Mg	Na
						%		
1	0	0	3.78	0.32	3.24	0.73	0.45	0.03
2	110	100	4.24	0.28	2.84	0.78	0.45	0.05
3	695	100	4.22	0.32	3.62	1.00	0.46	0.02
4	1305	100	4.49	0.32	4.10	0.96	0.40	0.02
5	415	375	4.22	0.28	3.58	0.90	0.35	0.02
6	110	630	4.55	0.30	3.18	1.00	0.44	0.02
7	695	630	4.40	0.32	3.70	0.74	0.36	0.02
8	1305	630	4.32	0.33	4.34	0.70	0.33	0.04
9	1000	910	4.26	0.30	4.39	0.84	0.33	0.02
10	110	630	4.32	0.33	4.19	0.76	0.32	0.03
11	695	630	4.52	0.28	4.30	0.80	0.29	0.03
12	1305	630	4.30	0.25	4.42	0.80	0.32	0.02

Table 6. Analysis of Leaf Tissue at 15 Weeks: Micronutrients

Treatment (lb/acre) No.	Urea	Muriate	Mn	Fe	Cu	Zn	B	Al
						ppm		
1	0	0	235	81	14	29	22	41
2	110	100	274	84	15	28	19	152
3	695	100	374	85	14	28	28	48
4	1305	100	299	80	14	29	25	28
5	415	375	238	75	12	23	23	64
6	110	630	384	76	12	24	25	46
7	695	630	245	69	13	32	22	46
8	1305	630	310	88	14	30	22	120
9	1000	910	402	106	12	30	24	108
10	110	630	297	82	10	28	23	96
11	695	630	316	79	12	26	24	94
12	1305	630	414	95	10	26	24	86

Figure 1. Avg. Weight No.1 Corm per Acre

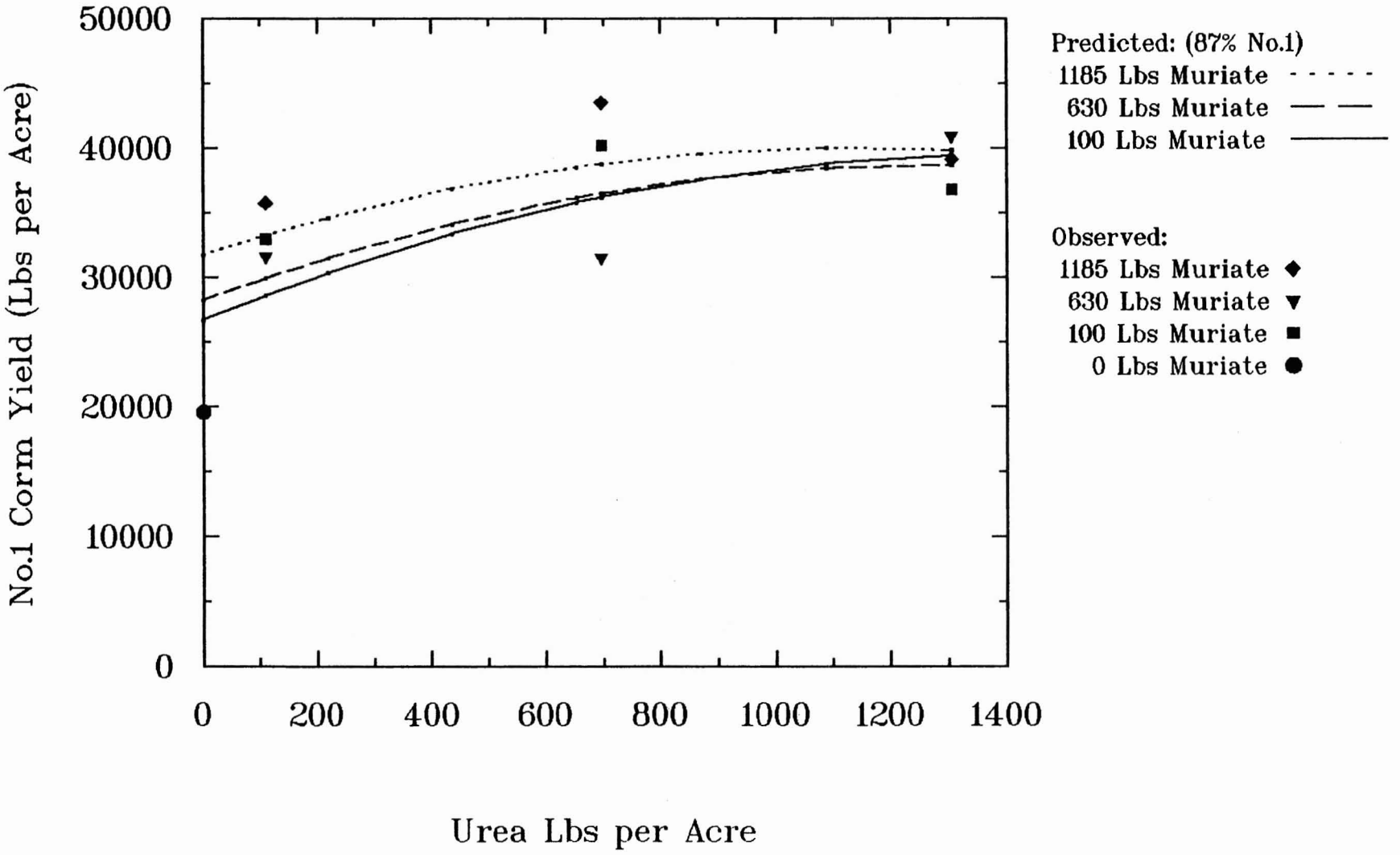


Figure 2.

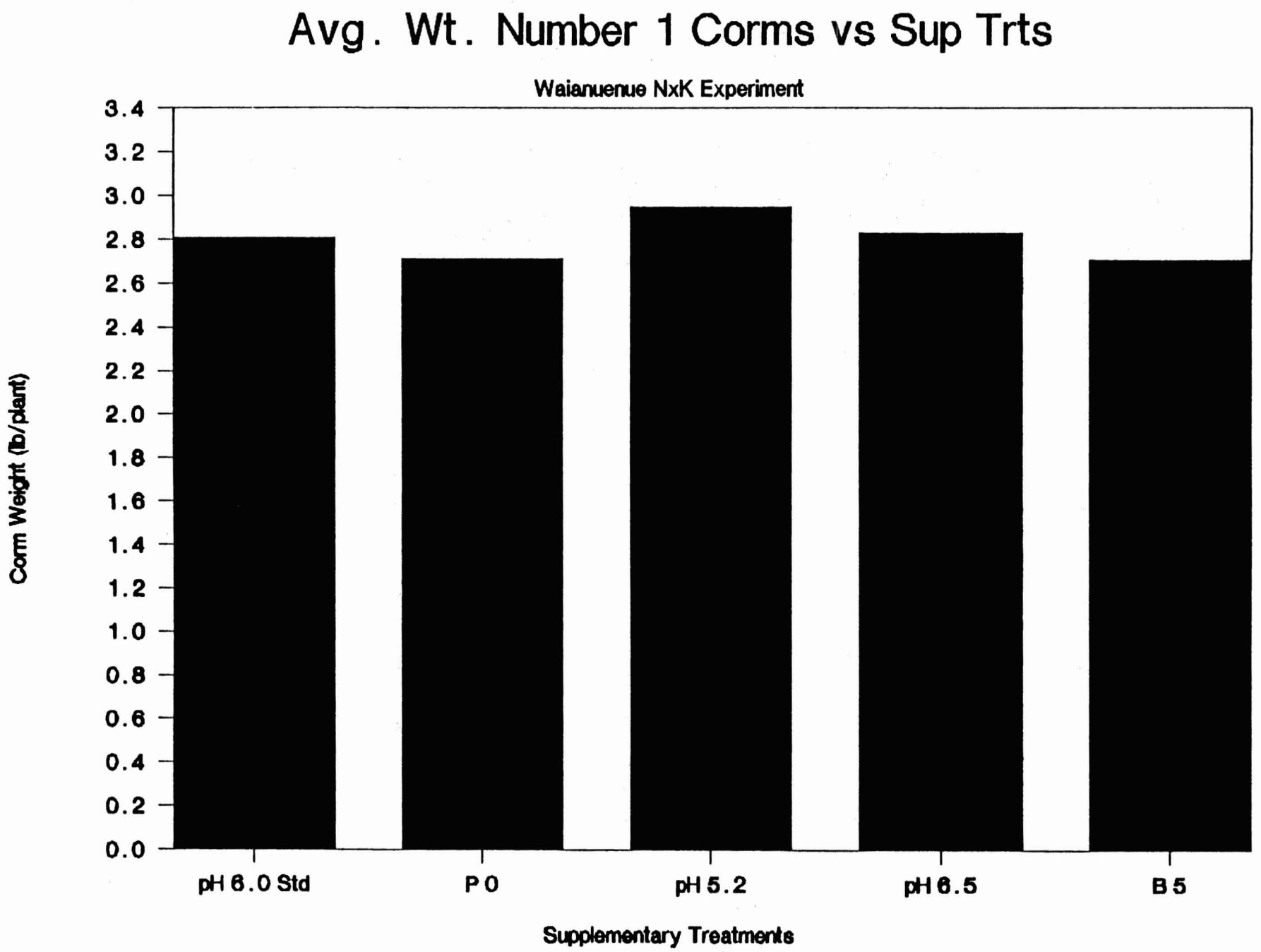

Avg. Wt. Number 1 Corms vs Sup Trts
Waianuenue NxK Experiment
Corm Weight (lb/plant)
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
pH 6.0 Std
P 0
pH 5.2
pH 6.5
B 5
Supplementary Treatments

Figure 3.

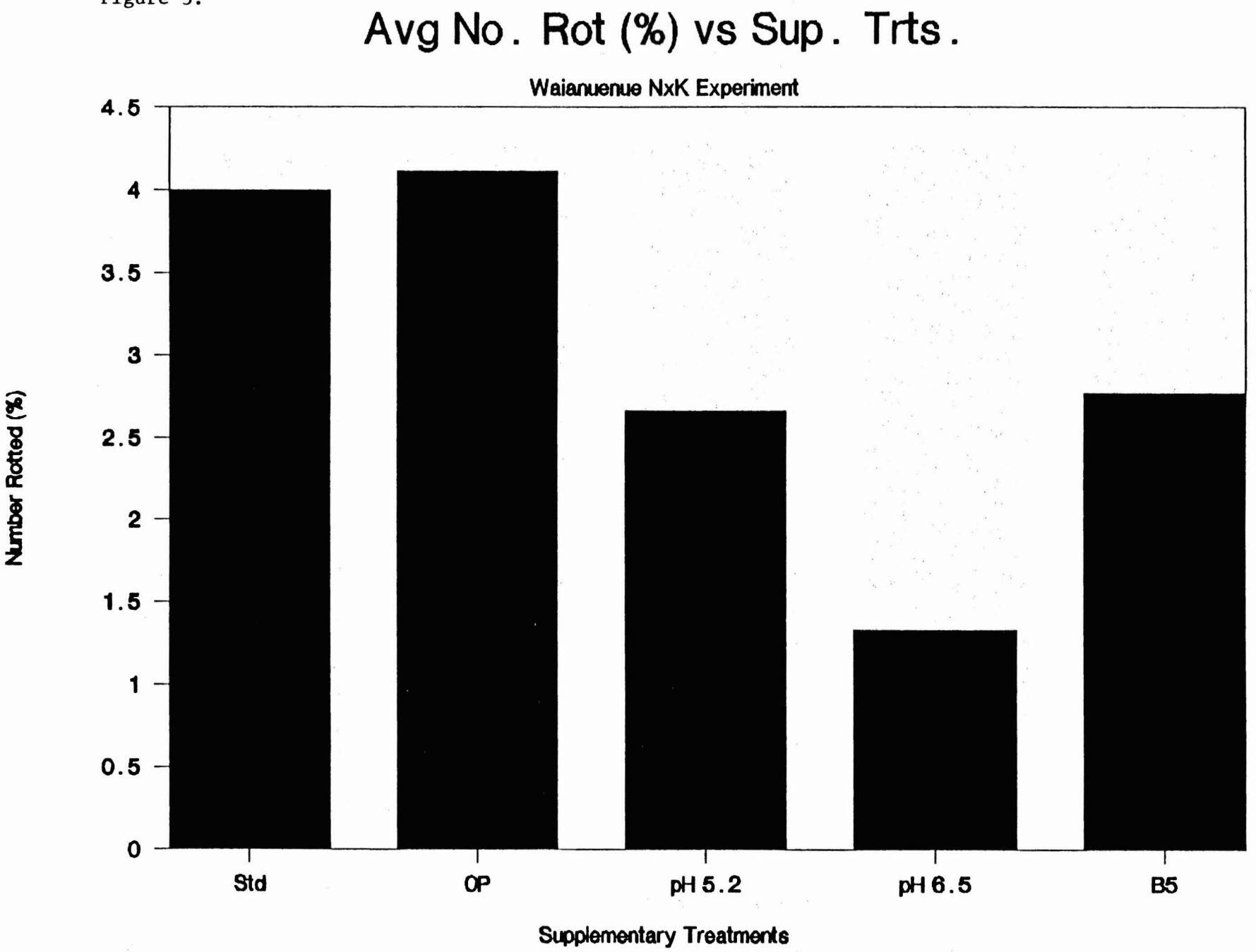
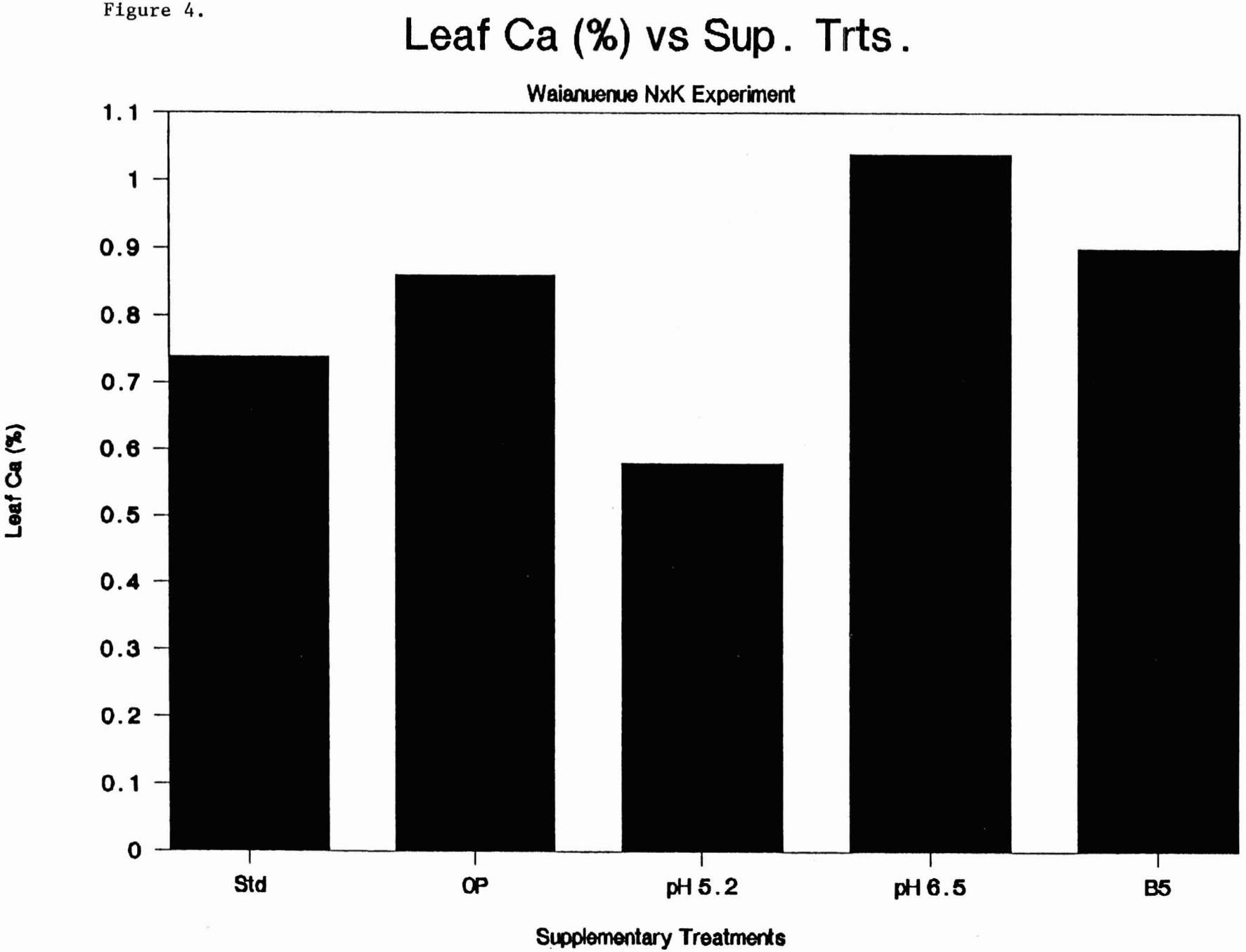
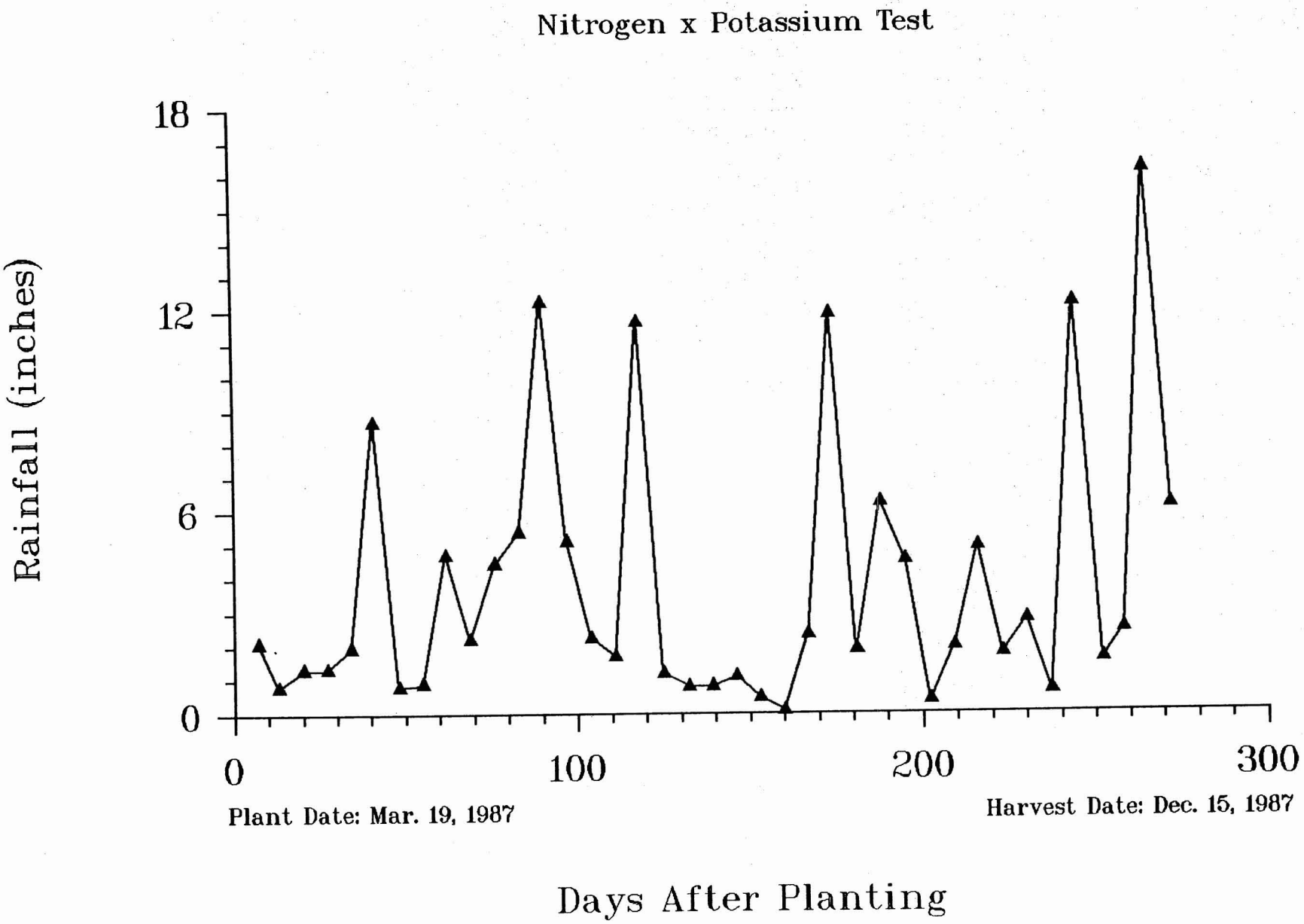

Avg No. Rot (%) vs Sup. Trts.
Waianuenue NxK Experiment
Number Rotted (%)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Std
OP
pH 5.2
pH 6.5
B5
Supplementary Treatments

Figure 4.


Leaf Ca (%) vs Sup. Trts.
Waianuenue NxK Experiment
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Leaf Ca (%)
Std
OP
pH 5.2
pH 6.5
B5
Supplementary Treatments

Appendix 1.

Weekly Rainfall vs DAP



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